NCERT Solutions for Class 12 Biology

Chapter 5 – Molecular Basis of Inheritance

1: Group the Following As Nitrogenous Bases and Nucleosides:

Adenine, Cytidine, Thymine, Guanosine, Uracil and Cytosine Ans:

Nucleosides	Nitrogenous Bases
Cytidine	Adenine
Guanosine	Thymine
	Uracil
	Cytosine

2: If a Double Stranded DNA has 20% of Cytosine, Calculate the Percent of Adenine in the DNA.

Ans: In the double helix model or in double-stranded DNA the ratio between the adenine and thymine molecule is the same, whereas the ratio between the guanine and cytosine is the same.

In 100% of DNA, if the percent of cytosine is 20% then the percent of guanine is also equal to 20%. By adding the percentage of cytosine and guanine, a total of 40% are present and the remaining 60% of DNA is formed by adenine and thymine.

Thus in DNA, there is 30% of adenine and 30% of thymine.

So, the percent of adenine in DNA is 30%.

3: If the Sequence of One Strand of DNA is Written as Follows:

5'-ATGC ATGC ATGC ATGC ATGC ATGC ATGC-3'

Write Down the Sequence of Complementary Strand in 5' → 3' Direction

Ans: The DNA double strands are complementary strands where one base pair forms pairing with other base pairs like adenine with thymine and cytosine with guanine. The given sequence of one strand is 5'- ATGCATGCATGCATGCATGCATGCATGC - 3'

In 3' to 5' direction the sequence will form like,

3'- TAC GTA CGTACG TAC GTA GTA CGTACG - 5'

Therefore, in 5' to 3' direction the sequence of the complementary strands will form like,

5'- GCA TGC ATGC ATGC ATGC ATGC ATGC AT - 3'

4: If the Sequence of the Coding Strand in a Transcription Unit is Written as Follows:
5'-ATGC ATGC ATGC ATGC ATGC ATGC ATGC-3'

Write Down the Sequence of mRNA.

Ans: In the transcription unit the coding strand does not code for anything therefore the sequence remains the same, only the thymine gets replaced by uracil.

If the given sequence is 5'- ATGCATGCATGCATGCATGCATGCATGC-3' Then the sequence of mRNA form will be 5' - AUGCAUGCAUGCAUGCAUGCAUGCAUGC-3'

5: Which Property of DNA Double Helix led Watson and Crick Hypothesis SemiConservative Mode of DNA Replication? Explain.

Ans: The following properties of DNA double helix led Watson and Crick hypothesis semiconservative model of DNA replication,

1. The antiparallel and complementary nature of DNA double-strand with respect to the base sequence. Due to this, each strand acts as a template strand for the synthesis of new strands.

2. Semi conservative nature of DNA due to the presence of one parental strand and one newly synthesized strand.

3. The sequence of the base of the template strand forms the sequence of the daughter strand due to the complementary nature of DNA.

6: Depending Upon the Chemical Nature of the Template (DNA or RNA) and the Nature of Nucleic Acids Synthesized from it (DNA or RNA), List the types of Nucleic acid Polymerases.

Ans: There are mainly four types of nucleic acid polymerases present, such as

- **DNA-dependent DNA polymerases-** It is the main polymerase enzyme that helps in replicating the parental strands(Template DNA) by which new strands of DNA form.

- **DNA-dependent RNA polymerase-** It is the main polymerase enzyme in the transcription process where the RNA gets formed by copying one strand of the DNA.

- **RNA-dependent DNA polymerase**

- **RNA-dependent RNA polymerase**

7: How Did Hershey and Chase Differentiate Between DNA and Protein in Their Experiment While Proving That DNA Is the Genetic Material?

Ans: Alfred Hershey and Martha Chase in 1952 work with the bacteriophage and E.Coli to find out the genetic material between DNA and protein by the following process.

1. To find out the genetic material between DNA and protein, they cultured some viruses in radioactive phosphorus and some in radioactive sulfur.

2. In radioactive phosphorus, the virus consists of radioactive DNA but not protein, whereas in radioactive sulfur the virus consists of radioactive protein but not radioactive DNA.

3. This radioactive virus and radioactive phages are then inserted into E.Coli which cause the spread of infection.

4. The viral coat gets removed by agitating the phages in the blender, due to this the virus particle gets separated from bacteria in a centrifuge.

5. The virus-carrying DNA transmitted the infection to bacteria whereas the viruscarrying protein does not.

Therefore it concluded that between DNA and protein DNA is the genetic material.

8:Differentiate Between the Following

1) Repetitive DNA and satellite DNA

Ans:

Repetitive DNA	Satellite DNA
1) It is a type of DNA sequence that consists of small repeated segments.	1) It is a type of repetitive DNA sequence that consists of highly repetitive DNA.

2) By density gradient centrifugation they can be separated from bulk DNA and in this form, they appear as light bands.	2) By density centrifugation, they can be separated from bulk DNA and in this, they appear as dark bands and small peaks.
3) The length may vary from small. A number of base pairs to hundreds and thousands of base pairs.	3) They are shorter in length and up to a hundred base pairs long.

2) mRNA and tRNA

Ans:

mRNA	**tRNA**
1) In the transcription process, it helps in providing the template and therefore it is also known as messenger RNA.	1) In transcription, it acts as an adaptor that brings the amino acids and reads the genetic code therefore it is also known as transfer RNA.

2) It has a linear shape.	2) It has an inverted L shape and it looks like a cloverleaf.
3) It shows attachment with ribosomes only	3) It shows attachment with both ribosomes and amino acids. From one end it is attached with a ribosome and from another end, it is attached with amino acids.

3) Template strand and coding strand

Template strand	**Coding strand**
1) During the transcription process, template strands work as a template for the synthesis of mRNA.	1) During the transcription process, the coding strand does not code for anything and acts as a complementary strand of the template strand.
2) It has a sequence complementary to the mRNA	2) It has a sequence identical to mRNA except that thymine in DNA is replaced by uracil in mRNA

3) Its direction is from 3' to 5'	3) Its direction is from 5' to 3'.

9: List Two Essential Roles of the Ribosome During Translation.

Ans: During translation, the two essential roles performed by the ribosomes are as follow:

- The synthesis of protein takes place by the ribosome because it acts as a cellular factory. It is divided into two subunits in its inactive state, one is a large subunit and one is a small subunit. In large subunits bind amino acids and when the mRNA enters in small subunits and by this the synthesis of protein begins.

- During translation ribosomes also act as catalysts for peptide bond formation and this catalyst is a ribozyme.

10: In the Medium Where E. coli Was Growing, Lactose Was Added, Which Induced the Lac Operon. Then, Why Does Lac Operon Shut Down Some Time After Addition of Lactose in the Medium?

Ans:

- In the lac operon, lactose acts as an inducer that regulates switching on and off of the operon. Apart from this lac operon also consists of one regulatory gene and three structural genes which are z,y and a.

- The regulatory gene I code for repressor and in structural gene the z code for betagalactosidase, y for permease and a-gene for transacetylase. The three structural genes metabolised lactose.

- When lactose was added to the E.Coli medium, it gets transported into the cell by the action of permease and shows binding with the repressor, due to this the RNA polymerase gets bind with the promoter region, hence the synthesis of products of the

structural gene get initiated which also led to the metabolization of glucose and galactose.

- Due to the metabolism of lactose, the level of lactose gets decreased and the formation of a repressor starts. The binding of the repressor to the operator prevents the transcription of RNA polymerase. This is called negative regulation because of the stoppage of the transcription process.

11: Explain(in one or two lines) the Functions of the Following:

(a) Promoter

Ans: (1) It initiates the process of transcription.

(2) It provides the binding site for RNA polymerase.

(b) tRNA

Ans: (1) It reads the genetic code of messenger RNA.

(2) During translation it carries a specific ribosome to mRNA to initiate the process.

(c) Exons

Ans: (1) It is the coding sequence of DNA that transcribes proteins.

(2) In between the long sequence of axons introns are present which disappear in the mature one.

12: Why is the Human Genome Project called a Megaproject?

Ans: Human Genome Project is called a megaproject because of the following reasons:

1. The human genome has 3×10^9 base-pair and if it is required 3 US dollars per base pair then its estimated cost will go approximately to 9 billion US dollars.

2. If its sequence were stored in a book in the typed form then each page will consist of 1000 letters and each book will consist of approximately 1000 pages which led to the formation of 3300 books from a single human cell.

For all this, high computational devices are required for data storage, retrieval and analysis.

13: What is DNA Fingerprinting? Mention its Application.

Ans: The technique which is used to identify and analyse the variation in DNA in every individual is known as DNA fingerprinting.

The various applications of DNA fingerprinting are as follow:

1. In forensic science, it is used for identifying potential crime suspects.

2. It is used for finding out paternity and family relationships.

3. It is used for the identification and protection of commercial crop varieties and livestock.

4. It is used to find out the evolutionary relationship and linkage between the various organisms.

14: Briefly Describe the Following:

Transcription:

Ans: The process of formation of mRNA from the DNA template is known as transcription. In this process, a single strand of DNA gets copied into mRNA. It starts at the promoter region of the template DNA and stops or terminates at the terminator region of the template. Between

these two regions, a transcription unit is present. The process of transcription is catalysed by DNA dependent RNA polymerase.

- Initiation, elongation and termination are the three main processes of transcription.
- At the promoter region of the template strand the DNA dependent RNA polymerase and initiation factor-like (σ) bind and the process of transcription gets initiated.
- Due to enzymes the DNA double helix unwinds and then one of the strands, called sense strand, starts mRNA synthesis and this strand is called the template strand. The process of transcription remains continuous until the terminator region.
- As the transcription enzymes reach the terminator region, the enzyme and the newly synthesised mRNA are released. The termination takes place by the termination factor(ρ).

Polymorphism

Ans: Polymorphism is a form of genetic variation in which distinct nucleotide sequences can exist at a particular site in a DNA molecule in a population. This heritable mutation is observed at a high frequency in a population. It arises due to mutation either in a somatic cell or in germ cells. The germ cell mutation can be transmitted from parents to their offspring. This results in the accumulation of various mutations in a population, leading to variation and polymorphism in the population. This plays a very important role in the process of evolution and speciation. Polymorphism in DNA sequences is the basis for gene mapping and DNA fingerprinting.

Translation

Ans: -Translation is the process of polymerizing amino acids to form a polypeptide chain. The triplet sequence of base pairs in mRNA defines the order and sequence of amino acids in a polypeptide chain.

The process of translation involves three steps :

Initiation

Elongation

Termination

During the initiation of the translation, tRNA gets charged when the amino acid binds to it using ATP. The start (initiation) codon (AUG) present on mRNA is recognized only by the charged tRNA. The ribosome acts as an actual site for the process of translation and contains two separate sites in a large subunit for the attachment of subsequent amino acids. The small subunit of ribosome binds to mRNA at the initiation codon (AUG) followed by the large subunit. Then, it

initiates the process of translation. During the elongation process, the ribosome moves one codon downstream along with mRNA so as to leave the space for binding of another charged tRNA. The amino acid brought by tRNA gets linked with the previous amino acid through a peptide bond and this process continues resulting in the formation of a polypeptide chain. When the ribosome reaches one or more STOP codons (VAA, UAG, and UGA), the process of translation gets terminated. The polypeptide chain is released and the ribosomes get detached from mRNA.

Bioinformatics

Ans: Bioinformatics is the application of computational and statistical techniques to the field of molecular biology. It solves the practical problems arising from the management and analysis of biological data. The field of bioinformatics developed after the completion of the human genome project (HGP). This is because an enormous amount of data has been generated during the process of HGP that has to be managed and stored for easy access and interpretation for future use by various scientists. Hence, bioinformatics involves the creation of biological databases that store the vast information of biology.

It develops certain tools for easy and efficient access to information and its utilization. Bioinformatics has developed new algorithms and statistical methods to find out the relationship between the data, predict protein structure and their functions, and cluster the protein sequences into their related families.